discussed below, the application is believed to be in condition for allowance. Hence, reconsideration and allowance are respectfully requested.

Applicant respectfully traverses the election of species requirement as bioactive compounds can include organic or inorganic compounds, and further organic bioactive compounds can include hydrocarbons and derivatives. Further, the claims reciting various coating materials depend on claim 1, which is a generic claim. Thus, allowance of claim 1, which as discussed below is believed to be in condition for allowance, should lead to allowance of these dependent claims as well. Hence, Applicant respectfully requests withdrawal of the election of species requirement.

Rejections Under 35 USC 112

The Office Action rejects claims 4-18, 20-29 and 33-39 as being indefinite.

With regard to claim 4, in response to Examiner's request for clarification, Applicant affirms that the step of "irradiating a gas contained within or flowing through said region of space with electromagnetic radiation…" is intended to indicate that irradiation is performed while the gas is flowing through this region.

In response to the question posed by the Examiner regarding the location at which the relationship defined by the formula of claim 8 is satisfied, Applicant points out that claim 8 depends on claim 4 that recites the step of providing a magnetic field within the spatially localized region of space in which the gaseous plasma is generated. Hence, it is clear that the location at which the relationship presented in claim 8 is satisfied is this region of space. Further, in response to the Examiner's comment regarding variation of the amplitude of a magnetic field over space along different field lines, Applicant notes that claim 8 recites that the magnetic field amplitude *approximately* satisfies the relation provided in this claim, and hence allows for some variation of the field strength over this region. Accordingly, withdrawal of the rejection of claim 8 is respectfully requested.

Claim 9 is canceled because it essentially recites the same relationship between the frequency of the electromagnetic radiation and the magnetic field amplitude as that recited in claim 8.

Claim 18 is amended to depend on claim 16, rather than claim 17. This amendment renders the recitation of "non-uniform" speed in amended claim 18 consistent with the recitation of "uniform" speed in claim 17.

Further, claims 17 and 18 are amended to recite that "different portions" of the tubular surface are drawn uniformly or non-uniformly, respectively, through the region in which the plasma is generated. The recitation of "different portions" rather than "selected portions" in amended claims 17 and 18 more clearly establishes the relationships between these claims and claim 16.

With regard to the objection raised with respect to claim 20, Applicant notes that claim 20 is canceled because the step of coating the surface is now incorporated in amended claim 1.

Claim 23 is amended to depend on claim 1, and hence the indefiniteness rejection of claim 23 is overcome.

In addition, claim 33 is amended to remove the recitation of "having a selected partial pressure." This amendment is believed to overcome the rejection of this claim for indefiniteness. Applicants note that this amendment does not narrow the scope of claim 33, and is made only for the purpose of expediting the prosecution of the application.

Rejections Under 35 USC 102(b)

The Office Action rejects claims 1-2, 4-5, 8-12, 16-17, 29 and 32-36 as being anticipated by U.S. Patent No. 4,897,285 of Wilhelm.

Claim 1, as amended, recites a method of treating a surface of a tubular article by generating a gaseous plasma within a spatially-localized region of space by electron cyclotron

resonance, and exposing at least a portion of a surface of the tubular article to the plasma for a selected time period to treat the surface. In a subsequent step, the treated surface is coated with a selected material.

Wilhelm is directed to a method of depositing a coating of a material onto a conductive inner surface of a waveguide. More particularly, a vapor phase atmosphere of the coating material is introduced into the waveguide, and a magnetic field is applied to a selected inner portion of the waveguide. Mircrowave radiation having an appropriate frequency is fed into and is allowed to propagate along the waveguide to generate a cyclotron resonance plasma within a region of the waveguide to which the magnetic field is applied. The generated plasma causes direct deposition of the coating material onto the waveguide's inner surface. The location of the magnetic field can be varied to coat different portions of the waveguide.

In Wilhelm, the plasma is utilized for *direct* deposition of a coating material onto a surface of a waveguide. In contrast, amended claim 1 recites a two step process in which the surface of the tubular article is initially treated by a plasma generated by electron cyclotron resonance, and in a *subsequent* step, the treated surface is coated with a selected material. Such a two-step process can provide certain advantages. For example, it allows deposition of large biomolecules onto a surface, which can be difficult or impossible to perform via a direct deposition technique, such as that described by Wilhelm.

Thus, claim 1 distinguishes patentably over Wilhelm. Further, claims 2, 4, 5, 8, 10-12, 16, 17, and 32 depend either directly or indirectly on claim 1, and hence are also patentable.

Independent claim 33, as amended, recites a method of treating an inner wall of a non-conducting lumen by placing a selected portion of the lumen in a treatment zone to which a magnetic field having a selected strength is applied. A gas, which is introduced into the lumen so as to be in contact with its inner wall, is irradiated with electromagnetic radiation having a frequency that is substantially equal to the electron cyclotron frequency at the selected strength of the magnetic field so as to ionize the gas and generate a plasma zone for treating the lumen's inner wall.

In Wilhelm, the inner surface of the waveguide that is subjected to plasma deposition is formed of a conducting material, which allows propagation of microwave radiation to the plasma region. In contrast, claim 33 is directed to treating an inner wall of a *non-conducting* lumen, which is not employed for microwave propagation, but rather is placed in the plasma zone so as to treat its inner wall. The present invention is based, in part, on the discovery that electron cyclotron resonance can be used to generate localized plasma zones within a non-conducting lumen to allow controlled treatment of its surface. This advantageously allows treating inner surfaces of a variety of tubular articles, such as, medical catheters. In contrast, Wilhelm's method is restricted to plasma coating of articles that are conducting and hence can be employed for microwave propagation.

Accordingly, claim 33 is patentable over Wilhelm. Claims 34-36 depend either directly or indirectly on claim 33, and are also patentable.

In paragraph 9, the Office Action rejects claims 6-7, 15, 18, and 37-39 as being obvious in view of the teachings of Wilhelm.

Claim 6-7, 15 and 18 depend on claim 1, and hence incorporate the patentable features of claim 1. As discussed above, Wilhelm fails to teach or suggest the patentable features of claim 1. Hence, claims 6-7, 15 and 18 are also patentable.

Claim 37 depends on independent amended claim 33, via claim 36, and hence incorporates the patentable features of this claim.

Claim 38 not only incorporates the patentable features of claim 1 but it also recites that the treatment can be any of smoothing or sealing the lumen wall. As discussed above, Wilhelm teaches direct deposition of a coating material onto the surface of a conducting waveguide. Wilhelm, however, does not teach or even remotely suggest treating the waveguide surface by the generated plasma in order to provide smoothing or sealing of the surface.

Claim 39 depends on claim 36, which in turn depends on claim 33, and hence incorporates the patentable features of claim 33. In addition, claim 39 recites that the treatment of the lumen wall can cause any of reducing friction, sterilizing, or bond scission. The Examiner states that the plasma conditions of Wilhelm will inherently have these effects. Applicant respectfully disagrees. Various plasma parameters, such as the gases utilized for generating the plasma, and other factors, such as duration of the exposure of a surface to the plasma, can determine whether these effects can be obtained. In other words, not every plasma would cause these effects. There is no indication that the plasma conditions of Wilhelm would cause reduction of friction, sterilization or bond scission of the waveguide's surface. Thus, claim 39 is patenable over Wilhelm.

In Paragraph 10, the Office Action rejects claims 19-22, 24, and 26-28 as being obvious in view of the combined teachings of Wilhelm and U.S. Patent No. 4,927,676 of Williams.

Claim 19 depends on claim 1, and further recites that the tubing is formed of the group consisting of electrically non-conductive organic polymer, and electrically non-conductive glass. As an initial matter, as discussed above, Wilhelm does not teach a two-step process of (1) treating a tubular article by ECR plasma and (2) coating the treated surface. Further, whereas claim 19 recites that the tubing is formed of a non-conducting material, Wilhelm is directed to plasma coating of a conducting waveguide. Further, Williams, which is directed to coating a lumen wall with endothelial cells, does not teach or suggest the use of an ECR plasma. In addition, there is no motivation to combine the teachings of Wilhelm with those of Williams as these references are directed to distinctly different problems. Whereas Wilhelm is concerned with coating conducting surfaces with inorganic material, such as TiN and SiC, Williams is directed to coating polymeric surfaces with cells.

Moreover, even if one combines the teachings of Wilhelm with those of Williams, one does not obtain the claimed subject matter of claim 19. In particular, replacing the waveguide of Wilhelm with a conduit made of a polymeric material, such as those described in Williams, does not allow propagation of radiation to the region containing the magnetic field, and hence destroys the functionaliy of the Williams apparatus.

Thus, claim 19 is patentable over the combined teachings of Wilhem and Williams.

Claims 21, 22, and 23, as amended, depend on claim 1, and hence incorporate the patentable features of this claim. Further, claims 27 and 28 depend, via claim 4, on claim 1. As discussed above, the combined teachings of Wilhelm and Williams fails to teach or suggest utilizing an ECR plasma in a two step process to first treat and then coat a surface of a tubular article. Hence, these claims distinguish patentably over the combined teachings of Wilhelm and Williams as well.

The Office Action further rejects claims 19-24 and 27-28 as being obvious over Wilhelm in view of U.S. Patent No. 5,486,357 of Narayanan.

As an initial matter, Narayanan describes treating polymeric surfaces, such as lumens of medical tubing, with a radiofrequency generated plasma, rather than an ECR plasma. Thus, Narayanan does not provide the advantages of the claimed method of the invention. For example, an ECR plasma provides a higher degree of spatial control for treating a surface than a radiofrequency plasma. Further, treatment of a surface by an ECR plasma is generally less time-consuming.

Moreover, there is no motivation for combining the teachings of Wilhelm with those of Narayanan as they relate to distinctly different applications. Whereas Wilhelm is directed to coating of conducting metallic surfaces of waveguides, Narayanan is concerned with coating of polymeric medical tubing. In addition, replacing metallic waveguide of Wilhelm with polymeric tubing of Narayanan destroys the functionality of Wilhlems' apparatus because the polymeric tubing does not allow microwave transmission.

Thus claim 19-23 and 27-28 distinguish over the combined teachings of Wilhelm and Narayanan.

The Office Action also rejects claims 19-23 and 27-28 as being obvious in view of the combined teachings of Wilhelm and U.S. Patent No. 5,942,277 of Makker.

Makker is directed to an apparatus for inserting an intraocular lens through a small incision into an eye. The apparatus includes a polymeric surface exposed to radiofrequency generated plasma. Similar to Williams, Makker employs a radiofrequency generated plasma, rather than an ECR plasma, to treat a polymeric surface. Thus, the arguments presented above with regard to the combined teachings of Wilhem and Williams apply with equal force to establish that the combined teachings of Wilhelm and Makker fail to render obvious the subject matter of claims 19-24 and 27-28.

In Paragraph 11 of the Office Action, claims 3, 19-28 and 31 are rejected as being obvious in view of the combined teachings of Wilhelm, and U.S. Patent No. 5,053,244 of Kieser and U.S. Patent No. 5,914,115 of Subramaniam.

Claim 3 depends on claim 1, and further recites that the surface to be treated by the ECR plasma is selected to be an outer surface of the tubular article. Both Wilhelm and Kieser describe a method for direct deposition of a coating material from a plasma onto a surface. In contrast, as discussed above, amended claim 1, and consequently claim 3, recite a two step process in which a tubular surface is first treated by an ECR plasma and is subsequently coated. Further, Subramaniam describes utilizing a glow discharge, rather than an ECR plasma, to functionalize surfaces of medical devices, such as catheters. In addition, there is no motivation to combine the teachings of these three references. For example, whereas Wilhelm is concerned with coating an inner surface of a metallic waveguide, Kieser is primarily directed to a distinctly different application of coating outer surfaces of objects such as window glass.

Hence, claim 3 is patentable over the combined teachings of the cited patents. The arguments presented above with respect to claim 3 apply with equal force to establish that claims 19, 22-28, which depend either directly or indirectly on claim 1, are also patentable.

New Claims

New independent claim 49 recites a method of selectively treating an outer surface of a tubular article by placing a selected portion of the article in a treatment zone, and applying a magnetic field having a selected strength to the treatment zone. A gas is introduced into a volume of the treatment zone so as to be in contact with an outer surface of the article. The gas in then irradiated with electromagnetic radiation having a frequency that is substantially equal to electron cyclotron frequency at the selected magnetic field strength so as to ionize the gas and create a plasma that is in contact with the outer surface of the article without being in contact with the inner surface of the article in order to treat the outer surface without treating the inner surface. Support for this claim can be found, for example, on page 9, and throughout the remainder of the specification. Thus, no new matter is added.

None of the cited references teaches or suggests such selective plasma treatment of an outer surface of an article. That is, none of the cited references teaches or suggests a method for treating an outer surface of a tubular article via plasma exposure *without* exposing the inner surface to the plasma.

New claim 50 is directed to simultaneous treatment of surfaces of a plurality of tubular articles by exposure to an ECR plasma. Support for this claim can be found, for example, on page 11 of the specification, and through the remainder of the specification including the figures. None of the cited references teaches such a simultaneous treatment of a plurality of tubular articles.

Hence, new claims 49 and 50 are patentable over the teachings of the cited references.

CONCLUSION

In view of the above amendments and remarks, the application is believed to be in condition for allowance. Hence, reconsideration and allowance of the application are respectfully requested.

Respectfully submitted,

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Listing of All Pending Claims

1. (Currently Amended) A method of treating a surface of tubular article, the method comprising the steps of:

A[1]

generating a gaseous plasma within a spatially-localized region of space by electron cyclotron resonance, and

exposing at least a portion of a surface of the tubular article to said plasma for a selected time period to treat the surface<u>, and</u>

<u>coating said treated surface with a selected material</u>.

2. (Original) The method of claim 1, wherein said surface is selected to be at least a portion of the lumen of the tubular article.

3. (Original) The method of claim 1, wherein said surface is selected to be an outer surface of the tubular article.

4. (Original) The method of claim 1, wherein the step of generating the gaseous plasma includes

providing a magnetic field having a selected strength within said region of space, and

irradiating a gas contained within or flowing through said region of space with electromagnetic radiation having a frequency substantially equal to electron cyclotron frequency at said magnetic field strength so as to ionize the gas and produce said gaseous plasma.

5. (Original) The method of claim 4, further comprising the step of selecting a partial pressure of said gas to be in a range of about 0.1 Pa to about 1000 Pa.

6. (Original) The method of claim 5, further comprising selecting the gas partial pressure to be in a range of about 1 Pa to about 10 Pa.

7. (Original) The method of claim 6, further comprising selecting the gas pressure to be approximately 5 Pa.

8. (Original) The method of claim 4, wherein the frequency of the electromagnetic radiation (f_c) and the magnetic field amplitude (B) approximately satisfy the following equation:

$$f_c = \frac{1}{2\pi} eB/m$$

wherein e and m are the charge and mass of an electron, respectively.

9. (Canceled)

10. (Original) The method of claim 8, further comprising selecting the radiation frequency to be in a range of about 1 GHz to about 15 GHz.

11. (Original) The method of claim 10, further comprising selecting the amplitude of the magnetic field to be in a range of approximately 300 Gauss to 5500 Gauss.

A cont

12. (Original) The method of claim 4, further comprising selecting a power level of the electromagnetic radiation to be in a range of 10 to 500 Watts.

13.(Original) The method of claim 12, further comprising selecting the power level to be in a range of about 75 Watts to about 150 Watts.

14. (Original) The method of claim 13, further comprising selecting the power level to be approximately 100 Watts

15.(Original) The method of claim 2, further comprising the step of selecting an inner diameter of said tubular article to be in a range of about 0.5 mm to about 20 mm.

16. (Original) The method of claim 1, further comprising the step of drawing said tubular article through said region of space so as to expose different portions of the tubular surface to said plasma.

17. (Currently Amended) The method of claim 16, further comprising selecting a uniform speed for drawing said tubular article so as to provide a substantially uniform treatment of [selected] said different portions of the surface of the tubular article.

18. (Currently Amended) The method of claim [17] 16, further comprising selecting a non-uniform speed for drawing said tubular article so as to effect a graded treatment of [selected] said different portions of the surface of the tubular article.

19. (Original) The method of claim 1, wherein said tubing is formed from the group consisting of electrically non-conductive organic polymer, and electrically non-conductive glass.

20. (Canceled)

A1 cont

21. (Currently Amended) The method of claim [20] 1, wherein said coating material is selected from the group consisting of an organic polymer, an inorganic material, and a bioactive material.

22. (Currently Amended) The method of claim [20] 1, wherein said coating material is selected to be any of anti-thrombogenic, anti-coagulant, anti-biotic or anti-microbial.

23. (Currently Amended) The method of claim [20] 1, wherein said [anti-coagulant] coating material is selected to be anti-coagulant heparin.

24. (Currently Amended) The method of claim [20] 1, wherein said coating material is selected to include any of one or more proteins, one or more vitamins, one or more minerals, or one or more enzymes.

25. (Currently Amended) The method of claim [20] 1, wherein said coating material is selected to have anti-inflammatory analgesic properties.

26. (Currently Amended) The method of claim [20] 1, wherein said coating material is selected to have cell growth properties.

27.(Currently Amended) The method of claim 4, further comprising selecting the gas from the group consisting of noble gases, diatomic gases, hydrocarbons, and fluorinated hydrocarbons and mixtures thereof.

28. (Currently Amended) The method of claim 27, wherein the gas can be selected to be any of argon, oxygen, nitrogen, methane, butane, and tetrafluoromethane and mixtures thereof.

29.(Canceled)

30. (Canceled)

A1. cont

31. (Original) The method of claim 3, wherein the exposure of the outer surface to the plasma effects any of smoothing, sealing, reducing friction, sterilizing, or bond scission of the surface.

32. (Original) The method of claim 2, wherein the exposure of the portion of the lumen to the plasma effects any of smoothing, sealing, reducing friction, sterilizing, or bond scission of the lumen.

33. (Currently Amended) A method of treating an inner wall of [a] an electrically non-conducting lumen, comprising the steps of:

placing a selected portion of said lumen in a treatment zone,

applying a magnetic field having a selected strength to the treatment zone,

introducing a gas into said lumen within said selected portion, said gas being in contact with the inner wall of said selected portion [and having a selected partial pressure],

irradiating said gas with electromagnetic radiation having a frequency selected to be substantially equal to electron cyclotron frequency at said selected magnetic field strength so as to ionize said gas and create a plasma zone within said selected portion, said plasma treating said <u>inner</u> wall of the lumen.

34. (Original) The method of claim 33, wherein the strength of said magnetic field is selected to be in a range of approximately 300 Gauss to 5500 Gauss.

35. (Original) The method of claim 34, wherein the frequency of the electromagnetic radiation is selected to be in a range of about 1 GHz to 15 GHz.

A' cont.

36. (Original) The method of claim 33, further comprising exposing the selected portion of the lumen to the plasma for a pre-defined time period in order to effect a selected treatment of the lumen.

37. (Original) The method of claim 36, wherein the pre-defined time period is in a range from about one second to about one minute.

38.(Currently Amended) The method of claim 37, wherein the selected treatment is any of smoothing or sealing the <u>inner</u> lumen wall.

39. (Original) The method of claim 37, wherein the selected treatment effects any of reducing friction, sterilizing, or bond scission of the lumen wall.

40. (Canceled)

41. (Canceled)

42. (Canceled)

43. (Canceled)

44. (Canceled)

45. (Canceled)

46. (Canceled)

47. (Canceled)

48. (Canceled)

A cont

49. (New) A method of selectively treating an outer surface of a tubular article, the method comprising the steps of:

placing a selected portion of said tubular article in a treatment zone,

applying a magnetic field having a selected strength to the treatment zone,

introducing a gas into a volume of the treatment zone so as to be in contact with an outer surface of the article,

irradiating said gas with electromagnetic radiation having a frequency selected to be substantially equal to electron cyclotron frequency at said magnetic field strength so as to ionize said gas and create a plasma in contact with said outer surface without being in contact with said inner surface so as to treat said outer surface without treating an inner surface of said article.

50. (New) A method of treating a surface of each of a plurality of tubular articles, the method comprising the steps of:

generating a gaseous plasma within a spatially-localized region of space by electron cyclotron resonance, and

simultaneously exposing a portion of a surface of each of the articles to said plasma for a selected time period to treat said surfaces.